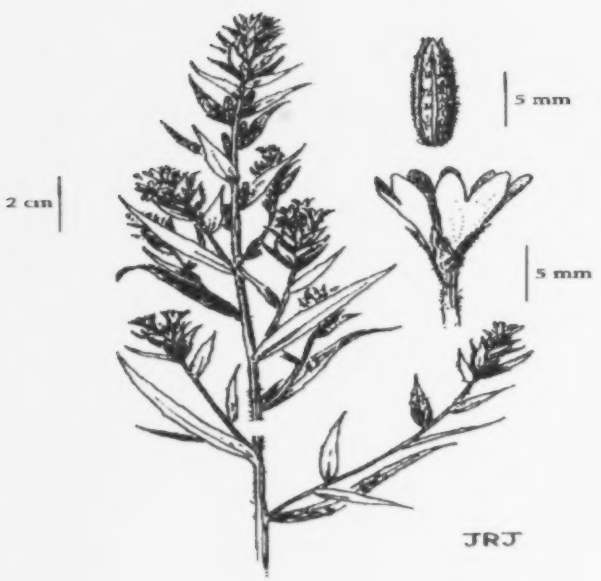
COSEWIC
Assessment and Status Report

on the

Dense Spike-primrose
Epilobium densiflorum

in Canada



ENDANGERED
2005

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION
DES ESPÈCES EN PÉRIL
AU CANADA

2007-00455

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Dense spike-primrose — Illustration by J.R. Janish from Hitchcock and Cronquist 1973 (with permission).

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COSEWIC
Assessment Summary

Assessment Summary – May 2005

Common name
Dense spike-primrose

Scientific name
Epilobium densiflorum

Status
Endangered

Reason for designation
An annual herb of a restricted habitat type within the Garry Oak Ecosystem that has undergone significant declines in number of populations and is subject to continued habitat reduction due to development and the spread of exotic weeds. The four extant populations are fragmented, small, and have little chance of being repopulated from adjacent sites in Washington State should they become extirpated.

Occurrence
British Columbia

Status history
Designated Endangered in May 2005. Assessment based on a new status report.

COSEWIC
Executive Summary

Dense Spike-primrose
Epilobium densiflorum

Species information

Epilobium densiflorum is a densely white-hairy annual herb arising from a taproot. Its leaves are essentially stalkless and alternate varying from elongate lance-shaped to ovate-lanceolate within the inflorescence. The rose-purple flowers are arranged in lateral spikes subtended by leafy bracts. The ripe capsules contain several seeds within each of the four chambers. Characteristically, the seeds lack the tuft of hairs (coma) that are present in most species of the genus.

Distribution

In Canada, *Epilobium densiflorum* occurs in southeast Vancouver Island. Its Canadian range extends north from Victoria to Nanaimo. It formerly occurred over a significantly larger area including Qualicum and North Pender Island. The nearest site outside Canada is on San Juan Island. The species ranges southward on both sides of the Cascades from Washington to Baja California and east to Idaho, Utah and Nevada. The species' current range in Canada covers less than 1,000 km^2 and it actually occupies an area of less than 0.1 km^2.

Habitat

In Canada, *Epilobium densiflorum* occurs within the Garry Oak Ecosystem in open meadows and ditches that are moist in spring and very dry in summer. An estimated 95% of the potential habitat has been lost over the past century due to agricultural, urban and industrial development along with fire suppression and invasion by exotic grasses and shrubs.

Biology

Epilobium densiflorum is an annual that flowers and fruits in mid- to late summer. It is predominantly self-pollinated but pollen may be transferred by bees and syrphid flies. The seeds are dispersed from the capsules in the late fall and winter. Unlike most species of *Epilobium*, the seeds lack a tuft of hairs (coma). As a result, they are not widely dispersed. The seeds germinate during the wet winter or spring but the plant continues to develop well into the summer drought period characteristic of southeast

Vancouver Island. The ability to tolerate high moisture levels in the winter and very low moisture levels in the summer allows it to grow where many other plants would succumb to environmental stress.

Population sizes and trends

Old collection data are imprecise and different names may apply to the same location. It appears that *Epilobium densiflorum* has been collected from between 19 and 31 sites since it was first observed in British Columbia in 1887. Suitable habitats in its area of occurrence have been heavily studied in the past 20 years, revealing a sharp decline in the number of populations. Only four extant populations are known with population No. 2 being reduced to a single reproductive plant in 2003. The four Canadian populations have an aggregate of about 2,800-3,400 individuals. The populations are severely fragmented and there is negligible probability of recolonization of any population, once lost.

Limiting factors and threats

The primary threats to *Epilobium densiflorum* in Canada come from habitat destruction due to residential development, and habitat alteration due to changes in hydrology and invasive plants. The last large population is threatened by a proposed trailer park development. The key limitations are its requirement for a pronounced summer drought and wet, mild winters — conditions that only prevail along a very restricted fringe of coastal habitat on and near southeast Vancouver Island.

Special significance of the species

The species, in Canada, likely represents a relict population that had a much broader distribution during the warm, dry Hypsithermal Interval, 4,000-6,000 years b.p. Aboriginal use of this species has been reported in a major ethnobotany database (http://herb.umd.umich.edu/).

Existing protection or other status designations

Epilobium densiflorum has no species-specific protection in Canada or elsewhere. Only one of the four extant Canadian populations occurs in a protected area. The habitat where the one protected population occurs is threatened with encroachment by woody species.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5th 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government members and the co-chairs of the species specialist and the Aboriginal Traditional Knowledge subcommittees. The Committee meets to consider status reports on candidate species.

DEFINITIONS (NOVEMBER 2004)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and it is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A wildlife species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.
** Formerly described as "Not In Any Category", or "No Designation Required."
*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994.

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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Dense Spike-primrose

Epilobium densiflorum

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2005

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SPECIES INFORMATION

Name and classification

Scientific name:	*Epilobium densiflorum* (Lindl.) Hoch & Raven
Synonym:	*Boisduvalia densiflora* (Lindl.) Wats.
	Oenothera densiflora Lindl.
Common name:	Dense spike-primrose
Family:	Onagraceae (Evening Primrose Family)
Major plant group:	Dicot flowering plant

Description

Epilobium densiflorum is an annual herb with a taproot. Stems are 15-100 cm tall, simple or branched above, peeling below. Plants are densely white-hairy to long soft- or stiff-hairy, and sometimes glandular. Leaves are alternate, except near the base, lanceolate, becoming narrowly egg-shaped in the inflorescence, 1-8.5 cm long, entire or remotely fine-toothed, upper ones hairy; unstalked or nearly so. Flowers in a crowded inflorescence of densely-leafy, terminal and lateral spikes; hypanthium 1.5-4 mm long; petals 3-10 mm long, white to rose-purple and notched at the tip. Sepals 2-9 mm long. Stigmas generally entire, rarely 4-lobed. Fruits are capsules, more or less spindle-shaped, long-hairy, 0.4-1.1 cm long, very short-beaked, 4-chambered and splitting in the middle of each chamber when ripe. Seeds 3-6 per chamber, flat, 1.2-2 mm long, with a net-like surface texture, hairless and brown, and without tufts of hairs (Douglas and Meidinger 1999; Figure 1).

Epilobium densiflorum varies greatly throughout its range. Plants with shorter, paler petals and shorter, eglandular hairs than the nominal variety have been referred to as var. *salicina*; this variety is currently not recognized as a significant taxonomic entity (Kartesz 1999). Many older floras place *E. densiflorum* in the genus Boisduvalia (*B. densiflora*), which differs from *Epilobium* by lacking a tuft of silky hairs at the summit of each seed.

Epilobium densiflorum may be mistaken for *E. torreyi*, another rare species in British Columbia. The two species may occur together. Table 1 summarizes significant differences between the two species.

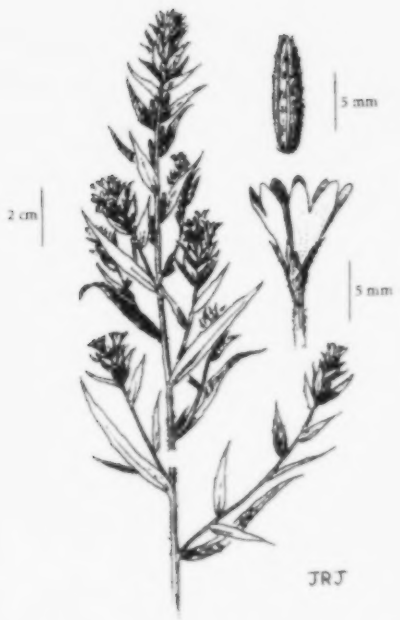

Figure 1. Illustration of *Epilobium densiflorum*: upper portion of plant (left); capsule (top right); flower (middle right). Illustration by J.R. Janish from Hitchcock and Cronquist 1973, with permission.

Table 1. Character comparison: *Epilobium densiflorum* vs. *E. torreyi*

Character	*Epilobium densiflorum*	*Epilobium torreyi*
Petal length	1-3 mm	(2.5) 3–8 (12) mm
Capsules	slenderly fusiform	narrower
internal septa	completely free from valves	adherent to valves
Flowers	crowded (inflorescence elongating in fruit)	usually not crowded
Leaves	lanceolate to ovate	linear to narrowly lanceolate
Vestiture	densely ashy-strigose to soft pilose, often glandular	villous-pilose

From Scoggan 1978-1979.

DISTRIBUTION

Global range

Epilobium densiflorum ranges from Vancouver Island and the southern Gulf Islands southward on both sides of the Cascades from Washington to California (rarer on the immediate coast and in the Central Valley) and northern Baja California, east to western Montana (extirpated), Idaho, Utah and Nevada (Scoggan 1978-1979, Hoch 1993, Hitchcock et al. 1961, Raven and Moore 1965). See Figure 2.

Figure 2. Global distribution of *Epilobium densiflorum*.

The nearest United States population is on San Juan Island in Washington State (Atkinson and Sharpe 1993), about 20 km from the nearest Canadian occurrence in Victoria.

Canadian range

In Canada, *Epilobium densiflorum* has been reported from two widely separated locations: southwest British Columbia and south-central Alberta (Figure 3). The single

record from Alberta is a historic 1911 collection at the Canadian Museum of Nature (CAN) made by M.O. Malte from the vicinity of Lethbridge (Scoggan 1978-1979; Michael J. Shchepanek pers. com. Dec. 16, 2002). This record is highly suspect and is here considered to reflect an error in locality labelling. It is dated August 27, 1911, but other herbarium records indicate Malte left Alberta sometime between August 3 (last known Alberta collection for that period) and August 7 (when he collected plants from Fernie, British Columbia). He subsequently collected material from Agassiz on August 18 and from Victoria on August 24 suggesting a single westbound trip. Malte was collecting in Alberta again, but not until 10 days later. Significantly, Malte's collections on August 24 included a specimen of *Epilobium densiflorum* from Victoria (Ksenija Vujnovic pers. com. Dec. 16, 2002, Joyce Gould pers. com. Dec. 30, 2002, BCCDC Herb Database Dec. 27, 2002).

Apart from Malte's questionable collection, *Epilobium densiflorum* has never been reported in Canada east of the Strait of Georgia (Ksenija Vujnovic pers. com. Dec. 16, 2002, Joyce Gould pers. com. Dec. 30, 2002). Although formerly known from Montana (where it has become extirpated) it was only found there once. The Montana specimen was collected in Sanders County, in a lowland area west of the Continental Divide (Montana Natural Heritage Program 2003). In conclusion, the balance of evidence suggests *Epilobium densiflorum* does not occur in Canada east of the Strait of Georgia.

The earliest collection was made by Macoun in 1887 from Departure Bay, Nanaimo. The total current and historical extent of occurrence (1887-present) in Canada (British Columbia) covers approximately 2,000 km^2, all within the Garry Oak Ecosystem. The current extent of occurrence is reduced to approximately 900 km^2. There is insufficient data to determine when most of the decline in the species' range occurred. Most of the decline can be attributed to the loss of the Qualicum population (apparently between 1910 and 2001) although a significant component occurred as a result of the loss of the North Pender Island population between 1981 and 2001.

HABITAT

Habitat requirements

Raven and Moore (1965) describe its habitat as wet places that are sometimes seasonally dry, from sea level to 2600 metres. In Canada, *Epilobium densiflorum* occurs in vernally moist meadows and roadsides (which dry below the permanent wilting point for much of the summer) in the dry coastal lowland zone (Coastal Douglas-fir zone – moist maritime subzone) of British Columbia (Douglas and Meidinger 2002). The permanent wilting point is reached when soil moisture has reached the point where it is not sufficient to meet the needs of a plant and it subsequently dies.

Gilkey and Dennis (1967) describe its habitat in Oregon as low ground and dried pools. In California, it occurs along stream banks and outwashes less than 2600 metres above sea level (Hoch 1993).

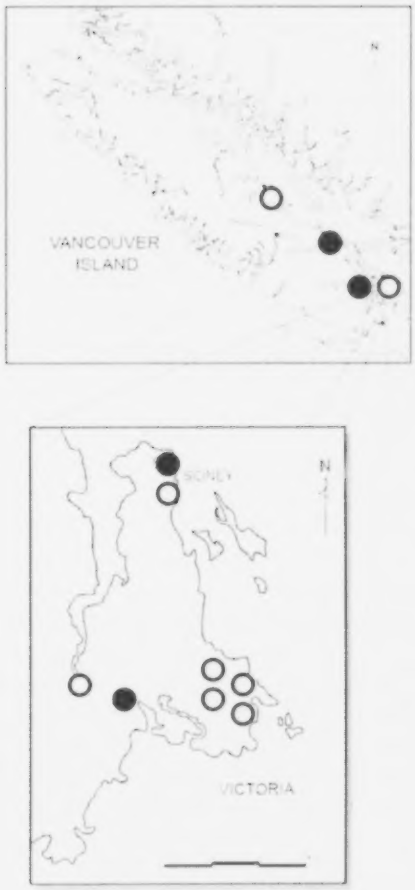

Figure 3. Canadian distribution of *Epilobium densiflorum* (solid black circles indicate extant populations, open circles represent extirpated populations).

In Montana, it occurred on a disturbed site in vernally wet soils around pools about 900 metres above sea level (Booth and Wright 1966, Montana Natural Heritage Program 2003). In Idaho, *Epilobium densiflorum* occurs on sites that are more or less moist early in the season, and then become dry later on (Davis 1952). In Utah, it occurs in marshy areas from 1310 to 1435 metres above sea level, in two counties (Welsh *et al.* 1987).

Trends

The amount of potential habitat has declined greatly over the past century as coastal areas in southeast Vancouver Island have been developed for residential and recreational use. Less than 1% of the Coastal Douglas-fir biogeoclimatic zone remains in a relatively undisturbed state (Pacific Marine Heritage Legacy 1996). Garry oak

ecosystems in the Victoria region have declined from 10,510 ha in 1800 to 512 ha in 1997 (Lea 2002); even more has been lost since then, and most of what remains has been heavily altered through invasion by exotic grasses and shrubs. Habitats suitable for *Epilobium densiflorum* have probably suffered proportional declines in area and quality.

This past trend in habitat destruction and alteration mirrors the loss of populations of *Epilobium densiflorum*. Most pre-1980 collections of *Epilobium densiflorum* lack precise location data, which makes it difficult to identify the changes that took place in their specific populations. Nine of the nineteen locales (Qualicum, Departure Bay, University of Victoria, White Rapids Road, Swartz Bay, Rithet's Bog, Uplands Park, King's Pond and North Pender Island) have seen widespread property development since the time of collection and it is likely that the occupied habitats were destroyed. Two other locales (Wallace Drive, Swan Lake) have been greatly modified by the invasion of robust species and it is likely the occupied habitats were substantially modified as a result.

Habitat protection/ownership

Population No. 4 lies within a park belonging to the Capital Regional District. This is the only site that currently has any formal protection. The Capital Regional District (CRD) has recently given the conservation and management of rare threatened and endangered plants and wildlife, and their supporting habitats, precedence over all other park uses (Capital Regional District Parks 2000). The City of Victoria planted *Abies grandis* on this site several years ago, before the area was transferred to the CRD. Apart from the threat posed by *Abies grandis*, the habitat has also been invaded by woody vegetation including *Crataegus monogyna* (introduced) and *Alnus rubra* (a native species). These woody species have had a serious impact on the habitat and may eventually lead to a decline in the population.

Population No. 1 and population No. 3 occur on private land. Population No. 2 occurs along a road allowance through Cowichan Tribal Lands (Indian Reserve property). The area occupied by population No. 1 is now the subject of a residential development proposal (pre-development environmental studies began in September 2003). Neither it nor the other two populations on private lands has any protection.

BIOLOGY

General

Epilobium densiflorum is an annual forb that flowers and fruits in mid- to late summer and probably germinates in the following spring.

Reproduction and dispersal

Epilobium densiflorum flowers in June through August. The species has been reported as predominantly autogamous (self-pollinated) and ovules may be fertilized by

pollen from the same flower (Seavey 1992). In contrast, Raven (1979) reports that pollen is transferred primarily by bees and to a lesser extent by syrphid flies. *Epilobium densiflorum* may occur with the closely related *E. torreyi*. Experimental crosses between the two species only produce capsules 33% and 43% of the time and their mature progeny may be sterile (Seavey 1992).

The seeds of *E. densiflorum* are irregularly angular and fusiform (Raven 1976) and the seed surface cells are concave with radial walls that are longitudinally striate and irregularly thickened (Seavey et al. 1977). The loculicidal capsules dehisce in the late fall and the seeds probably fall to the ground as the capsules are shaken during winter rains (Raven 1976). *Epilobium densiflorum* lacks two critical characteristics that aid wind dispersal by seeds of other species in the genus: an obovoid, flattened shape and the presence of a coma (Raven 1976). Strings of populations present along drainages could possibly reflect dispersal by water; however, no such evidence has been found. It is unlikely that such events play any significant role in seed dispersal since the populations occur in wet areas with no external drainage and in sites that are merely saturated with water but not flooded.

There is no information on seed banks in this species. Many of the sites are waterlogged for extended periods during the fall, winter and spring when conditions are ripe for fungal growth and seed deterioration.

Germination and seedling ecology

Seeds germinate when there is abundant water and may be submerged for a time (Raven and Moore 1965; Raven 1976).

Survival

Although this species germinates in moist places it matures and reproduces under xeric conditions. This makes it well-adapted to survive the gradual onset of summer drought characteristic of southeast Vancouver Island.

Physiology

There is no information on the physiology of *Epilobium densiflorum* that is relevant to assigning at-risk status or developing recovery plans.

POPULATION SIZES AND TRENDS

There have been an estimated minimum of 19 and perhaps as many as 31 reported occurrences of *Epilobium densiflorum* in Canada (Table 2). Suitable sites have been surveyed repeatedly since the early 1980s in a series of projects designed

Table 2. *Epilobium densiflorum* population data.

Population	Last collected or surveyed	Population Extent	No. of plants (2003)
No. 1	Fairbarns 2003	10,100 m^2	2,000-2,500
No. 2	Fairbarns 2003	1 m^2	1
No 3	Fairbarns 2003	2.5 m^2	50
No 4	Fairbarns 2003	40 m^2	800
Qualicum	Carter 1910	historical	0?
Departure Bay	Macoun 1887	historical	0?
University of Victoria	Hett 1962	historical	0?
Cedar	Ceska and Ceska 2001	apparently extirpated	0
White Rapids Road	Fairbarns 2003	apparently extirpated	0
Maple Bay	Ceska and Ceska 2001	apparently extirpated	0
Somenos	Fairbarns 2003	apparently extirpated	0
Swartz Bay	Fairbarns 2003	apparently extirpated	0
Wallace Drive	Fairbarns 2003	apparently extirpated	0
Rithets Bog	Fairbarns 2003	apparently extirpated	0
Uplands Park	Fairbarns 2003	apparently extirpated	0
King's Pond	Fairbarns 2003	apparently extirpated	0
Swan Lake	Fairbarns 2003	apparently extirpated	0
Spencer Pond	Fairbarns 2003	apparently extirpated	0
North Pender Island	Fairbarns 2003	apparently extirpated	0

to document the distribution of rare plants in open meadows in southeast Vancouver Island and the Gulf Islands. The principal investigators included Adolf and Oldriska Ceska, Chris Brayshaw, Hans Roemer, Harvey Janszen, Frank Lomer, George Douglas and Matt Fairbarns, all of whom are familiar with the species. Over 1,000 ha of suitable habitat in over 80 sites has been investigated and much of it has been surveyed more than once during this period. During the past decade alone, over 500 person-days have been spent searching for rare species in suitable habitats. This survey effort includes two searches specifically for *Epilobium densiflorum* (approximately 10 person-days in 2001 and 8 person days in 2003). Despite the concentrated effort, only four populations were found in surveys carried out in 2001 and or 2003. Both 2001 and 2003 appear to have been suitable years for surveying *Epilobium densiflorum*, based on the number and vigour of plants at population No.1 (2001, 2003), population No. 3 (2003), population No. 4 (2001, 2003) and population No. 2 (2001). The poor condition of population No. 2 in 2003 can be attributed entirely to physical site disturbance (see below).

Confirmed extant occurrences

Population No. 1

This large population has been known at least since 1999, although there are also a few older collections from Wellington with vague location data (e.g., Carter's 1912

collection = UBC 86850) that may have been made at this site. Over 2,000 plants were counted in 2001. Surveys in 2003 demonstrated that although the majority of the population occurs within the area surveyed in 2001, the occupied area actually extends several hundred metres beyond the 2001 survey area.

Population No. 2

This population has been known at least since it was observed by Adolf and Oldriska Ceska in 1992. It is not clear how many plants occurred on the site in 1992 but there were 40 plants in 1994 and 420 plants in 2001. Considering the absence of additional survey data between 1994 and 2001, this sizable increase in number of this annual species is not viewed as a case of extreme fluctuation in population size (>1 order of magnitude). Further survey data would be needed to justify this assertion. The population occurred in and around a shallow ditch along a dry gravel roadside. The soil remained moist late into the spring as it was fed with water from a short seasonal runlet. Between 2001 and 2003 the area was modified by road grading, the establishment of a new lane running up the slope, and piling of slashed shrubs. Only one plant was observed in 2003. This represents a decline of about 10% of the total population.

Population No. 3

This population has been known at least since it was collected in 1966 (UVIC 009971). Earlier collections from the Sidney area may have also been made in this area (e.g., Macoun's 1908 collection = CAN 83551). The population size and areal extent was not estimated in 1966, but there were 50 plants on the site in 2003 covering an area of approximately 2.5 m^2. Although the original 1966 collection locality is labelled somewhat differently, the 2003 observation likely refers to the same patch of plants. It occurs at the junction of two short roads, one of which was identified in the 1966 collection. No habitat similar to that indicated for the 1966 collection is found elsewhere in the area.

The property at the site of population No. 3 is a private lot. The plants grow in a shallow ditch or swale within a mowed residential lawn that is readily seen from the roadside. The main axis of most plants had been chopped off when the lawn was mowed but flowers had developed on axillary branches and fruit were already beginning to swell when the plants were observed in 2003.

Population No. 4

This large population has been known since 1958. The population appears to be relatively stable with numbers varying from 900 in August 1993, 750 in August 2001 and approximately 800 in August 2003.

Other reported occurrences

Historic collections

Qualicum

This population is represented by Carter's 1910 collection labelled "Qualicum, Vancouver Island" (UBC 86863) and perhaps by his 1916 collection labelled "Wellington and Little Qualicum" (V 003398). The coastal strip from Qualicum Beach north to the mouth of the Qualicum River has been heavily developed for residential and recreational use since the plants were collected but small areas of suitable habitat may remain. Suitable sites throughout the species' range in BC have been surveyed repeatedly, but with such a large extent of occurrence and the imprecise locality data for the historic Qualicum collection it is impossible to ensure that every patch of suitable habitat has been seen.

Departure Bay

This population is represented by a single collection made by Macoun in 1887 (CAN 83554). The area is now the site of a major ferry terminal and the vegetation has been dramatically altered by industrial development along with the establishment of many non-native grasses and forbs in the few remaining natural areas.

University of Victoria

This population was first reported in 1962 (UVIC 00967) and has not been seen since. It occurred under Garry oaks along a shaded trail. The Garry oak woodlands and meadows in and near the University of Victoria have been heavily impacted over the past 40 years. The disturbances include seeding and haying (which continued into the 1980s), temporary soil caching on the meadows during the Commonwealth Games and site development associated with the continued expansion of the university.

Extirpated populations

Cedar

This population, which occurred along the Cable Bay Trail, was near the boundary between private timber land and public land managed by the city of Nanaimo. There is limited data associated with the original observation. The original observers returned to the site in 2001 and did not find any plants. The population occurred in small, slightly depressional, shallow-soil pockets on a rocky slope dominated by meadow vegetation. The timber operator began a two-year timber harvesting operation in the vicinity. Their operations may have cut some of the Douglas-fir forests surrounding the meadow, and may have involved vehicle traffic on the meadow itself.

White Rapids Road

This population has been known at least since it was first collected in 1987 (V 171516). Earlier collections from the Wellington area may have also been made in this area (see above). Twenty-seven plants were observed in 2001 although it appears one of the subpopulations observed in 1987 had already disappeared by this point. Since then, the private property where the other two subpopulations occurred has been dramatically altered by clearing, fencing, draining and grazing. No plants could be found during a 2003 survey, although areas within the new fence were not comprehensively surveyed.

The known extent of the White Rapids Road population was separated from population No. 1 by a distance of no more than 3.5 km, and they may have once formed a single continuous population. The intervening area has now been altered by residential development and logging and appears to be unsuited to the species.

Maple Bay

This population, which occurred on private property, was first detected in 1986. The original collectors returned to the site in 2001 and did not find any plants. The shallow roadside ditch where they occurred had been deepened and the surrounding vegetation had changed from an open, grazed meadow to a tall dense sward dominated by *Phalaris arundinacea*.

Somenos Garry Oak Protected Area

The population occurred on unoccupied crown land that is owned by the province of British Columbia. The site was purchased by the crown in order to establish a protected area but it has not yet been designated as such.

This population has been known at least since it was first collected in 1992 (V 173045). It occurred in a narrow band of flat, seasonally wet area between wetlands along Somenos Creek and dry Douglas-fir forests sloping upwards to the east. The original observers returned to the site in 2001 and did not find any plants. The area was surveyed in great detail in 2003 for a number of rare species that had been previously reported. The former location of *Epilobium densiflorum* was visited on several different dates in 2003 but no plants were observed.

Portions of the flat area were irreversibly altered when contractors stockpiled fill for a proposed bridge across the creek. The bridge project appears to have been shelved but the fill remains on site. It is not clear whether the plants occurred in this precise area or elsewhere along the flat.

Spencer Pond

This population occurred on a seasonal pond that retains standing water through much of the summer and consequently has a central area dominated by emergent

wetland vegetation. There is limited data associated with the original observation. The original observers returned to the site in 2001 and did not find any plants. The site was surveyed carefully in 2003 and no plants were found at that time although there was still suitable habitat in the vicinity of the original observation.

A 1922 collection by Newcombe (labelled "Langford") may have come from the same population as the Spencer Pond plants (V 007046).

Swan Lake

This population is represented by a single collection made by Macoun in 1908 (CAN 83552). The area is now the site of a nature centre and trail system and has been visited by botanists regularly for many years. The vegetation around Swan Lake has been dramatically altered by hydrological changes and the establishment of many non-native grasses and forbs.

King's Pond

This population occurred on the Cedar Hill golf course, which is owned by the municipality of Saanich. There is limited data associated with the original observation. The original observers returned to the original collection site (on the west side of King's Pond) in 2001 and did not find any plants.

Detailed surveys were conducted in August 2003 around King's Pond as well as in an elongate wetland approximately 100 m to the south, dried-up vernal pools between the two, and upland grassy patches in their vicinity. The drawdown area surrounding King's Pond is dominated by a diverse assemblage of vigorous introduced species, including *Lythrum salicaria*. The upland grassy patches are gradually shrinking as patches of introduced shrubs (notably *Cytisus scoparius*) expand. The drawdown area around the elongate wetland is sparsely vegetated but the timing of drawdown may not favour *Epilobium densiflorum*. The vernal pools may have offered the most suitable habitat as standing water disappears relatively early in the growing season and they do not bear a dense cover of competing vegetation. *Epilobium densiflorum* was not observed in the 2003 survey and the population appears to have been extirpated, although the site should be resurveyed in years with different rainfall patterns to confirm this.

A 1920 collection by Anderson (labelled Cedar Hill) may have come from the same population as the King's Pond plants (V 041702).

Uplands Park

This population has been known at least since it was collected by Melburn in 1953 (V 101214). It was subsequently collected in 1956 (UVIC 009968) and 1961 (DAO collection number unknown). Earlier collections from the area may have come from the same population (e.g., Davidson's 1913 collection from "between Uplands and Tolmie" = CAN 83551 and Malte's 1911 collection from "Oak Bay" = CAN 197576)

Brayshaw (1991), in summarizing several years of observations, mapped several occurrences in Uplands Park. The park was surveyed unsuccessfully for occurrences of *Epilobium densiflorum* in 2001, and again in 2003 as part of a very detailed mapping exercise for numerous rare plants.

Rithet's Bog

This population, which occurred on public lands owned by the municipality of Saanich, was first found in 1951. The authors of this report surveyed the site extensively in 2001 and 2003 and were not able to find *Epilobium densiflorum*. Most of the wetland is now overgrown by willows and introduced grasses (notably *Phalaris arundinacea*).

Wallace Drive

This population was collected in 1966 (UVIC 009969) and has not been reported since then. The collector no longer recalls any details regarding the collection site or population (B. Turner, pers. com. August 2003). The label data describes a 3-km segment of Wallace Drive. This area was searched unsuccessfully in August 2003. About 50% of the survey area had been converted to agricultural, residential or light-industry use. The remainder of the search area was either never capable of supporting the species, or had been severely altered by ditching in the 1980s (Dave Fraser pers. com. October 8, 2003) and invasive exotic weeds.

Swartz Bay

This population was first collected by Ashlee in 1954 (UBC 87934). Ashlee collected plants from the same area in 1958 (V 034640). The collection site ("Swartz Bay, weedy fill at the end of landing ramp") has changed dramatically over the past 49 years and is now the main ferry terminal for Victoria. Most of this area is no longer capable of supporting vegetation. Remnant patches of weedy vegetation were surveyed without success in August 2003.

North Pender Island

The population occurred in a shallow, grassy roadside ditch by the old school on Pender Island, near Otter Bay. It was first collected by Janszen in 1981 (V 113544) but the site has been heavily impacted by construction activities over the past few years and *Epilobium densiflorum* is unlikely to persist (Harvey Janszen pers. com. 2003).

Misidentified collection

Courtney

Reports of *E. densiflorum* on mud flats at Courtney were based on a photograph that was later determined to be a different species (R. Walker, pers. com. August 2003).

Imprecise locations

A number of herbarium specimens of *Epilobium densiflorum* with imprecise location information on their labels may have come from one of the above locations. These include:

1. Sea's Farm, near Victoria: This 1893 Macoun collection (CAN 83548) may have come from one of several Victoria locations. There is no record of where "Sea's Farm" was located.

2. Vicinity of Sidney, Vancouver Island: This 1908 Macoun co''ection (CAN 83551) may have come from population No. 3 or the historical occurrence at Swartz Bay.

3. Sidney: This 1913 Macoun collection (V 003397) may have come from population No. 3 or the historical occurrence at Swartz Bay.

4. Sidney: This 1927 Goddard collection (V 008256) may have come from population No. 3 or the historical occurrence at Swartz Bay.

5. Saanichton: This 1931 Newcombe collection (009071) may have come from the same population as the historical occurrence on Wallace Drive.

6. Victoria, between Uplands and Tolmie: This 1913 Davidson collection (UBC 26117) may have come from the same population as the historical occurrences at King's Pond, Uplands Park or the University of Victoria.

7. Cedar Hill: This 1920 Anderson collection (V 007046) may have come from the same population as the historical occurrence at King's Pond.

8. Oak Bay, British Columbia: This 1911 Malte collection (CAN 197576) may have come from the same population as the historical occurrence at Uplands.

9. Goldstream: This 1896 Anderson collection (V 03399) may have come from the same population as the historical occurrence at Spencer Pond.

10. Langford: This 1922 Newcombe collection (V 007046) may have come from the same population as the historical occurrence at Spencer Pond, or alternatively from wet depressions that used to exist along the shores of Langford Lake.

11. Wellington, Vancouver Island: This 1912 Carter collection (UBC 86850) may have come from population No. 1 or the historical occurrence at Departure Bay.

12. Wellington and Little Qualicum: This 1916 Carter collection (V 003398) may have come from population No. 1 or the historical occurrence at Qualicum.

LIMITING FACTORS AND THREATS

Climatic limitations

In Canada, *Epilobium densiflorum* is restricted to a small area of southeastern Vancouver Island. This area, which is highly correlated with the distribution of Garry oak, has mild winters and dry, cool summers. The four extant populations and most or all of the historical populations occur close to the Pacific Ocean. Winter temperatures are moderated by proximity to the ocean, which is dominated by mild waters of the California Current all year long. Summer temperatures are lower near the ocean and daily maximum temperatures often increase by several degrees as one moves inland on a warm summer day.

Edaphic limitations

Edaphic factors strongly limit the distribution of *Epilobium densiflorum* within southeastern Vancouver Island and the adjacent Gulf Islands. The low-elevation band of coastal environments is narrow and quickly gives way to uplands that lack the necessary mesoclimatic conditions. Broken terrain over much of the lowland band creates many cool north- and east-facing slopes where forest plants have a comparative advantage. Well to moderately-well drained soils favour forests. Shallow, outcropping rock is common in the coastal fringe and provides too little moisture to sustain *Epilobium densiflorum*.

It appears that the suitable soil conditions only occur in a small fraction of the landscape where the soil is too wet in the winter to allow woody species to flourish, and yet too dry in the summer to support wetland species.

In summary, edaphic factors limit *Epilobium densiflorum* to a small portion of a climatic region which itself is restricted to a very small area of Canada.

Habitat loss

The loss of habitat (described earlier) is likely to continue into the future. The distribution of *Epilobium densiflorum* in Canada lies at the heart of one of North America's fastest growing regions. The Victoria Metropolitan Area includes two of the four extant populations of *Epilobium densiflorum* and many of the apparently extirpated populations. The population of metropolitan Victoria has increased from approximately 180,000 in 1966 to 318,000 in 1996 and is projected to increase to more than 400,000 by 2026. The Capital Regional Plan adopted in 1959 led to expansion into rural areas surrounding Victoria over the past 44 years and this pattern of expansion may continue in order to accommodate population increases (Capital Regional District Regional Growth Strategy 2003a). During past the 18 years, average prices for single family residences in Metropolitan Victoria have increased 330% from $94,000 to $313,000, reflecting the pent-up demand for property (Capital Regional District Regional Growth Strategy 2003b).

Similar projections apply to the Nanaimo Regional Districts, where *Epilobium densiflorum* also occurs. The population of the Regional District of Nanaimo increased from 77,624 residents in 1981 to 127,016 residents in 2001, and is projected to increase to 219,321 residents by 2026 representing an average growth rate of approximately 2.9% per year and a total increase of 73% over 1981 to 2026 (British Columbia Statistics Population Section, 2003).

The real estate market within the Regional District of Nanaimo saw above-average growth during 2002-2003, due to low mortgage rates and consumer confidence in the prospects of the provincial economy. According to the Canada Mortgage and Housing Corporation (2003), housing starts in Nanaimo were 57.7% higher in the first quarter of 2003, compared to the first quarter in 2002. The momentum of starts is expected to continue through 2003 as low housing inventories in British Columbia and strong consumer demand continue to support sales activity (Canada Mortgage and Housing Corporation 2003). Despite the rocky terrain, the site where population No. 1 occurs has high potential for residential development due to the broad panoramas provided of the surrounding landscape.

The most pressing threat to *Epilobium densiflorum* in Canada comes from the potential development of site 1 supporting the largest of the remaining populations. As of July 28, 2004, there were no current development applications on the property where population #1 occurs (Kevin Brydges pers. comm. 2004). There have been, however, two recent attempts to develop the site for residential purposes and it remains the property of a real estate developer. Consequently, site development remains a potential threat to this population.

Threats associated with altered fire regimes

Pre-European fire regimes in the dry coastal belt of southeast Vancouver Island are probably more complex than is generally reported. There is no doubt that First Nations in the area used fire extensively to stimulate the growth of food species — particularly *Camassia* bulbs that provided a storable form of starch (Turner and Bell 1971). Fire may also have been used to improve forage for game species (elk and deer).

Frequent low-intensity burns killed young red alder and Douglas-fir and checked the growth of trembling aspen and most shrub species — notably *Symphoricarpos albus* and *Rosa nutkana*. The resulting increase in light levels and decrease in competition favours the growth of herbaceous plants such as *Epilobium densiflorum*. Even the composition of the herb layer was altered, since many highly competitive plants decrease under a regime of frequent burning (Turner and Bell 1971, Roemer 1972, and pers. obs.).

First Nations' fire management practices also played a significant role in the development (and therefore fertility) of soils. The organic component of the upper mineral horizon would not be greatly reduced by low-intensity fires because it accumulated through the *in-situ* decomposition of root material. In contrast, the surface organic materials did burn, rather than accumulate, releasing nutrients. Since the main

inputs of organic matter came from herbs rather than coniferous trees, the upper mineral horizon also had a relatively neutral reaction in sharp contrast to the acidic nature of soils under Douglas-fir forests. As well, the frequent fires provided a continuous supply of "safe sites" where the small seeds of *Epilobium densiflorum* may have been able to germinate and grow without the stifling influences of surface organic horizons.

Threats associated with livestock grazing

In some respects, livestock grazing during the early 20th century may have offset the impacts of altered fire regimes. They convert recalcitrant foliage litter into labile forms (primarily dung), releasing nutrients in a form available to plant growth (Stoddart et al. 1975). The persistence of *Epilobium densiflorum* at many sites (e.g., Uplands Park) until the late 20th century may have been partly related to the lingering affects of livestock activity earlier in the century. Livestock owners may have created or maintained open habitats such as is found at the site for population No 4. Such open habitats are now shrinking as the cover of forest trees increases (pers. obs.).

More significantly, livestock grazing also played a major role in the establishment and eventual dominance of exotic forage species, which appear to have pre-empted sites where *Epilobium densiflorum* formerly flourished.

Threats associated with invasive alien plants

Invasive plants pose the most striking threat in most open habitats in southwestern British Columbia. Extant populations of *Epilobium densiflorum* were seen growing in a matrix dominated by invasive alien shrubs (e.g., *Crataegus monogyna*, *Cytisus scoparius*, *Rubus armeniacus* and *R. laciniatus*), grasses (e.g., *Agrostis gigantea*, *A. stolonifera*, *Aira caryophyllea*, *A. praecox*, *Anthoxanthum odoratum*, *Bromus hordeaceus*, *Cynosurus echinatus*, *Holcus lanatus*, *Phalaris arundinacea* and *Vulpia bromoides*) and herbs (e.g., *Barbarea vulgaris*, *Hypericum perforatum*, *Hypochaeris radicata*, *Leucanthemum vulgare*, *Lythrum salicaria*, *Plantago lanceolata*, *Ranunculus repens*, *Rumex acetosella* and *Vicia sativa*).

Invasive species threaten *Epilobium densiflorum* in many ways. Taller plants may suppress it by shading it out. Many alien species may out-compete it for moisture (particularly in the late spring and early summer) and nutrients. The most serious threat posed by alien annual species is their ability to pre-empt "safe sites" — recent soil disturbances that would be favoured by *Epilobium densiflorum* were it not for the ubiquity of annual invasives. Perennial aliens appear to establish permanent cover in sites that formerly provided a constant supply of bare mineral soil.

Limitations on a potential rescue effect

The nearest United States populations of *Epilobium densiflorum* occur on San Juan Island, where it is rare and is only known from a few sites. These populations

are about 20 km from the nearest recorded Canadian population in Victoria. It does not occur elsewhere in the San Juan Islands (Atkinson and Sharpe 1993).

There is little likelihood of interchange between Canadian and American populations because of the species' limited powers for unassisted dispersal (unlike most species of *Epilobium*, it lacks a coma to assist in wind dispersal). Similarities in habitat suggest that seeds from U.S. populations may be relatively well adapted to site conditions that prevail where Canadian populations occur, so there is some potential for deliberate re-introduction if Canadian populations are extirpated by events that do not reduce habitat suitability.

SPECIAL SIGNIFICANCE OF THE SPECIES

Epilobium densiflorum is an example of a species that has undergone a substantial loss in numbers of populations as a consequence of urban expansion and loss of habitat within the critically impacted Garry Oak Ecosystem. The species may also represent a relict from the Hypsithermal Interval of warm, dry climate 4,000-6,000 years b.p. as suggested by its distribution.

Aboriginal use of this species has been reported in a major ethnobotany database (http://herb.umd.umich.edu/).

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Epilobium densiflorum is not covered under the Convention on International Trade in Endangered Species (CITES), the Endangered Species Act (USA) or the IUCN Red Data Book. It is ranked globally secure (G5, NatureServe 2003).

Epilobium densiflorum is ranked critically imperiled (S1) in British Columbia, the only Canadian jurisdiction where it occurs. There is no current provincial legislation protecting plants at risk. Only one of four populations (#4) occurs in a protected area (provincial park), and there is no specific management or implementation plan to protect it there.

The Capital Regional District has a policy of protecting rare, threatened and endangered plants but no specific legislation or regulations to support this policy. Neither is there any specific reference to *Epilobium densiflorum* or to the park where it occurs.

TECHNICAL SUMMARY

Epilobium densiflorum
Dense Spike-primrose — épilobe densiflore
Range of Occurrence in Canada: British Columbia

Extent and Area Information	
• *Extent of occurrence (EO)(km²)* **Sum of the coastal area within which extant populations occur.**	900 km²
• *Specify trend in EO*	declining (loss of North Pender Is. population since 1981)
• *Are there extreme fluctuations in EO?*	no
• *Area of occupancy (AO) (km²)* **Sum of the individual separate localities.**	0.1 km² (10.1 ha)
• *Specify trend in AO*	declining
• *Are there extreme fluctuations in AO?*	no
• *Number of known or inferred current locations*	4
• *Specify trend in #*	declining
• *Are there extreme fluctuations in number of locations?*	no
• *Specify trend in area, extent or quality of habitat*	declining
Population Information	
• *Generation time (average age of parents in the population)*	<1 year
• *Number of mature individuals*	2,850-3,350
• *Total population trend:*	declining
• *% decline over the last/next 10 years or 3 generations.*	10%
• *Are there extreme fluctuations in number of mature individuals?*	no
• *Is the total population severely fragmented?*	severely fragmented with no reasonable likelihood of genetic exchange
• *Specify trend in number of populations*	declining
• *Are there extreme fluctuations in number of populations?*	no
• List populations with number of mature individuals in each: Pop. No. 1: 2,000-2,500 Pop. No. 2: 1 Pop. No. 3: 50 Pop. No. 4: 800	
Threats (actual or imminent threats to populations or habitats)	
- existing threats: habitat destruction (residential development); habitat alteration (altered hydrological regime, invasion by alien plants) - potential threats: housing developments covering site 1	
Rescue Effect (immigration from an outside source)	
• *Status of outside population(s)?* USA: G5 – globally secure, but rare in San Juan County (USA) and absent from other counties adjacent to southwest British Columbia	
• *Is immigration known or possible?*	no
• *Would immigrants be adapted to survive in Canada?*	unknown
• *Is there sufficient habitat for immigrants in Canada?*	not likely
• *Is rescue from outside populations likely?*	no

Quantitative Analysis [provide details on calculation, source(s) of data, models, etc.]	N/A
Current Status COSEWIC: Endangered 2005	

Status and Reasons for Designation

Status: Endangered	**Alpha-numeric code:** A3c; B1ab (i, ii, iii, iv,v) + 2ab (i, ii, iii, iv, v)
Reasons for Designation An annual herb of a restricted habitat type within the Garry Oak Ecosystem that has undergone significant declines in number of populations and is subject to continued habitat reduction due to development and the spread of exotic weeds. The four extant populations are fragmented, small, and have little chance of being repopulated from adjacent sites in Washington State should they become extirpated.	
Applicability of Criteria **Criterion A** (Declining Total Population): Meets endangered A3c with a 75% loss anticipated if all or most of population 1 is lost due to housing or other commercial development.	
Criterion B (Small Distribution, and Decline or Fluctuation): Meets Endangered B1ab (i,ii,iii,iv,v) + 2ab (i,ii,iii,iv,v) based on its small extent of occurrence and area of occupancy, only 4 remaining populations and continuing decline in extent of occurrence, area of occupancy (loss of most of population 2), quality of habitat (exotic weeds), number of populations and number of mature plants. **Criterion C** (Small Total Population Size and Decline): Meets threatened C1, based on a population of <10,000 and a potential future decline projected of about 75% if most of population 1 is lost to site development. **Criterion D** (Very Small Population or Restricted Distribution): Meets threatened D2 based on a very small area of occupancy and occurrence at only 4 locations with ongoing threats from urban expansion and exotic weeds. **Criterion E** (Quantitative Analysis): N/A	

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

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Vujnovic, Ksenija. Botanist. Alberta Natural Heritage Information Centre.

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BIOGRAPHICAL SUMMARIES OF REPORT WRITERS

Matt Fairbarns has a B.Sc. in Botany from the University of Guelph (1980). He has worked on rare species and ecosystem mapping, inventory and conservation in western Canada for approximately 20 years.

Brenda Costanzo has an M.Sc. (Botany) from the University of Victoria (1994). She was the Assistant Curator of the Herbarium at the University of Victoria (UVIC) from 1989 until 2001. Brenda has done extensive fieldwork in botany and recently worked on the preparation of fact sheets for "Plants at Risk in Garry Oak and Associated Ecosystems" for the Garry Oak Ecosystems Recovery Team (GOERT). She is currently the Species at Risk Recovery Team Coordinator for forest dependent species at the Ministry of Water, Land and Air Protection in Victoria.

Adolf Ceska, Pro. Biol. (Charles, Prague), Ph.D. (Victoria) is a botanist and plant ecologist. He is a recently semi-retired and free-lance consultant, former Visiting Assistant Professor, University of Victoria, Curator of Botany in the Royal British Columbia Museum and Program Ecologist, Conservation Data Centre. He is the author of several floristic and taxonomic papers and treatments, co-inventor of a computer technique for vegetation classification and an electronic publisher of BEN (Botanical Electronic News). His personal herbarium of over 30,000 specimens is deposited in the Royal British Columbia Museum.

Oldriska Ceska, Pro.Biol. (equivalent to=M.Sc.) Charles University in Prague. Oldriska Ceska is a tireless field botanist with extensive experience throughout the Pacific Northwest. Mrs. Ceska has over 35 years experience in ecological research, mycology, and botany, with special emphasis on rare plant inventory and surveys. As a chemotaxonomist she developed techniques for chemical identifications of water milfoils and discovered the yet undescribed chemical compound coriandrin from cilantro. She

has participated in numerous floristic and vegetation studies throughout British Columbia, focusing on cryptogams, fungi, and taxonomically difficult plants. She has taken part in many professional field trips throughout the Pacific Northwest in Washington, Oregon, and northern California. She has authored or co-authored over 50 papers, many of them in reviewed scientific journals.

COLLECTIONS AND DATABASES EXAMINED

The following collections were consulted:

- University of British Columbia herbarium (UBC)
- Royal BC Museum herbarium (V)
- University of Victoria herbarium (UVIC)

The following database was consulted

- HERB: the rare plant records database of the British Columbia Conservation Data Centre